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ABSTRACT

A preliminary investigation of patterns of teacher thought about student reasoning and learning involved presenting 23 preservice teachers with a "dilemma of practice about equity." Resulting stages of teacher development concerning equity in reasoning were found to correlate significantly with Perry's scheme. However for those who hold the view that mathematics learning is mostly rule-based, no significant correlation was found with theses stages of teacher thought about reasoning and equity. Yet, holding a rule-based viewpoint of mathematics learning was found to correlate significantly in the expected direction with Perry's scheme. Contains 17 references. (Author/MKR)

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Achieving Cognitive Equity in the Mathematics Classroom

Marcia L. Tharp and Chris Lovell

Paper presented at the Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education

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ACHIEVING COGNITIVE EQUITY IN THE MATHEMATICS CLASSROOM

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A preliminary investigation of patterns of teacher thought about student reasoning and learning involved presenting 23 preservice teachers with a "dilemma of practice about equity." Resulting stages of teacher development concerning equity in reasoning were found to correlate significantly with Perry's scheme (r=.39, p<.10). However for those who hold the view that mathematics learning is mostly rule-based no significant correlation was found with these stages of teacher thought about reasoning and equity. Yet, holding a rule-based viewpoint of mathematics learning was found to correlate significantly in the expected direction with Perry's scheme (r=-43, p<.05).

In an effort to achieve equity, the Professional Standards For Teaching Mathematics (NCTM, 1991) call for mathematics teachers to develop an extensive multicultural knowledge base and especially to know how students' linguistic, ethnic, racial, gender, and socioeconomic backgrounds influence learning of mathematics. As a result, researchers have begun to examine how teachers' conceptions of equity influence pedagogical practice. Most school-based conceptions of equity (Secada, 1994) focus on how teachers work with differences among students such as gender, race, ethnicity, and class. In the everyday classroom, these differences recurrently manifest themselves as differences in reasoning, and preservice teachers are enjoined to attend to such differences by honoring each child's reasoning process through careful probing and non-negative critical questioning (NCTM, 1991). What is missing in this general research line on cognition in the classroom, however, is a description of differences among the teachers, *themselves*, in their beliefs about learning and equity and how such beliefs might be, in turn, related to the cognitive developmental levels of the teachers.

Since it has been recognized that how teachers view reasoning and mathematics is a key determinant of how they teach mathematics (Simon and Schifter, 1991), it is imperative that educators examine how equity may be engaged in the classroom by teachers who hold varying conceptions of reasoning and learning mathematics. Thus the question arises: do differences among teachers on the dimension of cognitive development relate to how they reason about student differences in reasoning? When teachers invoke "equity" as a basis for instructional moves, does such an equity position relate to cognitive stage? The purpose of this research was to answer these questions and to investigate more generally teacher thinking about instruction, mathematics learning, and equity.

Method

A preliminary investigation of patterns of teacher thought about student reasoning and learning involved presenting 23 graduate-level, preservice teachers with a "dilemma of practice about equity" (Table 1), a dilemma which was selected to elicit strategic instructional thinking along with reasoning about possible

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ethical action. Respondents were asked to give their reasoning on the dilemma in the form of a short essay protocol. The resulting projective protocols were then subjected to a process of content analysis (Miles and Huberman, 1994) where certain qualitative themes, or "structures of knowing" relating to adult development were identified. Theories of increased sophistication in perspective taking (Selman, 1980; Commons, & Richards, 1984), of moral and ethical development (Kohlberg, 1984; Gilligan, Ward, Taylor, & Bardige, 1988), and of intellectual development (Perry, 1970; Belenky, Clinchy, Goldberger, & Tarule, 1986) guided the classification of the 23 master's level preservice teachers into stages of cognitive development.

Table 1. *A Dilemma Of Equity In Practice*

The following is a description of a challenge encountered in the life of a teacher. Please take time to give your reasoning on this incident.

> A white female elementary school teacher in the United States posed a math problem to her class one day. "Suppose there are four blackbirds sitting in a tree. You take a sling shot and shoot one of them. How many are left?" A white student answered quickly, "That's easy. One subtracted from four is three." An African immigrant youth then answered with equal confidence, "Zero." The teacher chuckled at the latter response and stated that the first student was right and that, perhaps, the second student should study more math. From that day forth, the African student seemed to withdraw from class activities and seldom spoke to other students or the teacher.

What are your thoughts on this matter?

Results

Four patterns of response were discerned, each corresponding to a theoretical stage of teacher development (Stage 1, a hypothesized level "silent knowing," was not evident in the sample.):

Stage 2 (authority centered/self-protective). The preservice teacher-respondent gives or implies "higher authority" as a motive for probing student reasoning. Equity issues are either omitted or couched in reactive terms. Example: "The teacher should have asked the African youth what her reasoning was. We have been learning how important it is for teachers to do this." Further, the respondent, projecting herself or himself into the dilemma, often stresses themes of defensiveness. Equity action is sometimes seen as a punitive move. Example: "The negative response

to the child's answer was insensitive to say the least. She should have asked him why he gave that answer. He, I'm sure, had his own logical reasons for his conclusion, but due to her prejudice he was not able to explain. She should be relieved of her job."

Stage 3 (mutualism). Equity action is viewed as an extensive, distributive process; undifferentiated equity ("fairness") demands that all students' reasoning be valued equally. Example: "The teacher seems to consider there is only one answer to the question. She/he didn't think there might be more than one answer to the question. From my point of view, the second child is equally correct. Perhaps that is not relevant to what the teacher had in mind, but nonetheless, the second child should not be put down for his line of thinking."

Stage 4 (autonomy/proceduralism). Stress is given to the teacher's autonomous ability to select and teach procedures for knowing and valuing (mathematical operations, ethical guidelines, and so forth). Equity is differentiated along lines more complex than simple rule-based heuristics; comparison of reasoning methods is emphasized. Equity is viewed as instrumental to instructional ends. Example: "What a *great* answer from that child! Of course it would be zero because all the birds would have flown away! His answer was based on real-world experience. The other, 'one subtracted from four' was textbook in nature. I would show the class both points of view."

Stage 5 (contextual relativism/constructivism). The teacher at this stage sees that instruction is a complex process, full of contingencies and resonating with many voices constructing knowledge together. Opportunities to capitalize on "the found curriculum," the "teachable moment," and classroom co-constructive possibilities are emphasized. Likewise, equity decisions are viewed as complex, principled, and interactive processes. An example: "The African was talking about his real life observation of birds. The other was answering a math question, thinking of a mathematical operation. The teacher's thinking was narrow in scope. She should have *not* done any comparing of students' answers. She could have had success with including the African by simply asking, 'Why do you say that is the answer?' Then the African, still confident, would have enlightened her and the rest of the class."

Two respondents showed evidence of stage five (9%) thinking in which classroom co-construction and non-judgmental comparison of reasoning are emphasized. The remaining 91% were categorized in lower stages of autonomy/proceduralism (22%), mutualism (39%), and authority centered/self protection (30%). This distribution of respondents accords with research investigations where cognitive developmental schemes were applied to higher education (Pascarella & Terenzini, 1991). As a check on this classification, a quantitative measure accord-

ing to the Perry Scheme (Moore, 1989) was administered to the respondents, revealing a moderate correlation to a general index of cognitive development (r = .39, $p < .10$). As a further check on the validity of the classification, correlation was sought with a measure of teacher perspective on mathematics learning, the View of Learning Math as a Rule-Based Subject (VLMRBS). This instrument (Tharp, 1992), assesses the degree to which a teacher adheres to the view that mathematics learning is mostly oriented toward processes which involve the manipulation of symbols and memorization of facts as opposed to the view that learning mathematics is based on reasoning about relationships and patterns. Since the differences measured by the VLRMBS strongly suggest a cognitive developmental sequence, the researchers turned to this "rule-based" measure. Correlation with the hypothesized teacher stages did not reach significance, although the VLRMBS did itself correlate significantly in the expected direction with the general index on the Perry measure (r = -.43, $p < .05$). Correlations between the "rule-based" measure (VLMRBS) and the four Perry levels again confirmed the inverse relationship between teacher view of mathematics learning as a rule-based process and teacher level of cognitive development (Table 2).

Table 2

Pearson Correlations Between Preservice Teacher View of Mathematics as a Rule-Based Subject (VLRMBS) and Level of Cognitive Development According to the Perry Scheme (N=23)

	Correlation to VLRMBS	
Perry Level	*r*	*p*
Position 2	.30	.17
Position 3	.37	.09*
Position 4	-.46	.03**
Position 5	-.19	.40

Bartlett χ^2 = 141.973, $p < .01$, df = 10

*Significant at the .10 level or better. **Significant at the .05 level or better.

Conclusions

According to Secada (1991, p. 49) an equitable mathematics education would include, "real contexts that reflect the lived realities of people who are members of equity groups." While Secada (1991) has argued that all children should see themselves as part of a mathematics curriculum regardless of their background, these results show that preservice teachers are not always ready to provide instruction that fully honors that background. Only nine percent of the preservice teachers at stage five hold a radically different view from those at lower stages that allows for the practice of "active equity", where individual reasoning is sought out to magnify the growth in understanding of an entire group. Since this sample is

representative of other research on cognitive development in higher education (Pascarella & Terenzini, 1991), one may expect similar results would be reflected in classroom practice. Though researchers have begun to recognize learning as a process of "shared knowings" that involves an entire mathematics community (Simmon, 1995), the present study calls into question the easy assumption that most teachers are cognitively disposed to facilitate mathematics community learning. Because NCTM reforms call for teachers to succeed in reaching all learners, the researchers conclude teachers will need to be assisted in moving to a stage of cognitive development that allows them to recognize the value of fully honoring diverse perspectives in the classroom as a tool for learning.

While this stage model can serve as a way of conceptualizing how teachers view their role in regard to reasoning about honoring the expression of student thinking and equity, interplay with specific student and teacher beliefs about mathematics learning that may run counter to constructing "shared knowings" cannot be ignored. Approximately 50 percent of students hold a view that learning mathematics is rule-based, i.e. mostly process-oriented and memorization (Kouba et. al., 1988). Thompson (1992) has suggested that some communication is effected between the beliefs of students and those of teachers. Given that preservice teachers' view of learning mathematics as "rule-based" is correlated positively with Perry stages 2 and 3 and negatively with higher stages, connections to this viewpoint should be investigated further and considered by educators who desire to move teachers to a stage where "active equity" is practiced and "shared community knowing" is sought.

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